

WHAT IS CLAIMED IS:

- 1 1. A functionalized silsesquioxane nanoparticle having a
2 maximum dimension of less than 100 nm, comprising a silsesquioxane
3 macromonomer containing minimally 6 and preferably up to 24 silicon atoms, and
4 comprised of in excess of 67 mol percent $\text{RSiO}_{3/2}$ moieties, wherein R is a phenyl
5 group or a phenyl group bearing one or more reactive functional groups, or an
6 oligomer or polymer of said macromonomer linked through Si-O-Si bonds, wherein
7 at least one of said phenyl groups bears a reactive functional group.
- 1 2. A method of preparing the functionalized silsesquioxane
2 macromonomers of claim 1, said method comprising providing a phenyl-substituted
3 silsesquioxane and substituting phenyl group(s) of said phenyl-substituted
4 silsesquioxane with a reactive functional group or precursor thereof.
- 1 3. The method of claim 2, comprising nitrating phenyl groups
2 of said phenyl-substituted silsesquioxane to form a nitrophenyl-substituted
3 silsesquioxane followed by reducing the nitrophenyl groups to aminophenyl groups
4 to form an aminophenyl-substituted silsesquioxane.
- 1 4. The method of claim 2, wherein said phenyl-substituted
2 silsesquioxane is functionalized by electrophilic substitution of a functional group
3 or precursor thereof for a ring hydrogen of the phenyl substituents.
- 1 5. The method of claims 2 to 4 wherein said reactive functional
2 group is selected from the group consisting of halo, amino, imino, epoxy,
3 carboxylic acid, carbonyl chloride, carbonate, isocyanate, cyanate, maleimide,
4 ethylenic unsaturation, ethylnic unsaturation, hydroxyl, acyl, hydroxyalkyl, and
5 sulfonyl.
- 1 6. The functionalized silsequioxane of any claims 1 - 5 wherein
2 said silsesquioxane nanoparticle has a cage structure and contains 6 to 24 and
3 preferably 8 reactive functional groups.

1 7. A nanocomposite material containing the functionalized
2 silsesquioxane macromonomer of claim 1 or a functionalized silsesquioxane
3 macromonomer prepared by the method of any of claims 2 to 9, or Si-O-Si linked
4 oligomers or polymers thereof.

1 8. The nanocomposite material of claim 7 comprising a
2 multilayer structure, said multilayer structure comprising layers of the functionalized
3 silsesquioxane of claim 1 or of functionalized silsesquioxanes prepared by the
4 process of any of claims 2 to 9, or Si-O-Si linked oligomers or polymers thereof.

1 9. The nanocomposite material of claims 7 or 8 wherein
2 alternating layers of functionalized silsesquioxanes are chemically bonded by means
3 of di-or polyfunctional spacer molecules.

1 10. The nanocomposite material of claim 9 wherein said spacer
2 molecules comprise a non-phenyl substituted, functionalized silsesquioxane
3 macromonomer, preferably an octakis (epoxyalkyl) silsesquioxane.

1 11. The nanocomposite material of any of claims 7 to 10 which
2 have a core/shell structure.

1 12. The nanocomposite material of claim 7 comprising the
2 functionalized silsesquioxane of claim 1 or the functionalized silsesquioxanes
3 prepared by the process of any of claims 2 to 9 or Si-O-Si linked oligomers or
4 polymers thereof as a dispersed phase, chemically bonded to a continuous thermoset
5 or thermoplastic polymer matrix.

1 13. The functionalized silsesquioxane of claim 1, selected from
2 the group of octakis(aminophenyl)silsesquioxane, octakis(N-
3 maleimidoaminophenyl)silsesquioxane, octakis(acetylphenyl)silsesquioxane, and
4 octakis-(bromophenyl)silsesquioxane).

1 14. The use of the nanoparticles of claim 1 or the functionalized
2 phenylsilsesquioxanes prepared by the method of claims 2 to 6 as luminescent
3 nanocomposites for display applications; nanocomposite porous media for filtration,
4 sieving, trapping or concentrating of materials; nanocomposites which are
5 electrically conductive; nanocomposites which exhibit high strength and thermal
6 stability; and nanocomposites which are flame resistant.

1 15. In a process for the preparation of a functionalized
2 silsesquioxane wherein a silica source is converted to polyanionic form employing
3 a quaternary ammonium hydroxide, followed by reaction with a
4 hydridoalkylchlorosilane to form a silsesquioxane bearing hydridosilyl-functional
5 reactive groups, and optionally employing said silsesquioxane bearing hydridosilyl-
6 functional reactive groups to hydrosilylate an unsaturated organic compound, the
7 improvement comprising selecting as the silica source a silica source obtained from
8 the combustion or calcination of silica-containing natural products.

1 16. The process of claim 15 wherein said silica source is one or
2 more of fly ash or rice hull ash.